US009472988B2

(12) United States Patent
Sonoda et al.

(10) Patent No.: US 9,472,988 B2
(45) Date of Patent: Oct. 18, 2016

(54) **ROTARY ELECTRIC MACHINE AND METHOD OF MANUFACTURING THE SAME**

(75) Inventors: **Isao Sonoda**, Chiyoda-ku (JP); **Atsushi Sakaue**, Chiyoda-ku (JP); **Satoru Akutsu**, Chiyoda-ku (JP)

(73) Assignee: **Mitsubishi Electric Corporation**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 522 days.

(21) Appl. No.: **14/110,747**

(22) PCT Filed: **Aug. 29, 2011**

(86) PCT No.: **PCT/JP2011/069422**

§ 371 (c)(1),
(2), (4) Date: **Oct. 9, 2013**

(87) PCT Pub. No.: **WO2013/030913**

PCT Pub. Date: **Mar. 7, 2013**

(65) **Prior Publication Data**

US 2014/0028130 A1 Jan. 30, 2014

(51) **Int. Cl.**

H02K 3/26 (2006.01)
H02K 15/02 (2006.01)
H02K 3/28 (2006.01)
H02K 3/52 (2006.01)

(52) **U.S. Cl.**

CPC ***H02K 3/28*** (2013.01); ***H02K 3/522*** (2013.01); ***H02K 15/02*** (2013.01); *H02K 2203/09* (2013.01); *Y10T 29/49009* (2015.01)

(58) **Field of Classification Search**

CPC H02K 3/28; H02K 3/522; H02K 15/02; H02K 2203/09; Y10T 29/49009
USPC 310/43, 71; 29/596
IPC H02K 3/28, 15/02
See application file for complete search history.

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Primary Examiner — John K Kim
(74) *Attorney, Agent, or Firm* — Sughrue Mion, PLLC; Richard C. Turner

(57) **ABSTRACT**

A rotary electric machine according to the present invention includes a stator having a connection member forming a three phase delta connection by coil windings, including an insulating annular groove portion formed with double annular grooves and a first, a second, and a third annular conductive members, the annular conductive members being attached by insertion into the insulating annular groove portion; the insulating annular groove portion is formed with double grooves of one and the other, and both the grooves are connected via one window portion; the respective annular conductive members are each formed in a circular arc shape and provided with a plurality of arm portions extended outward in the radial direction of the stator, the plurality of arm portions being connected to coil end portions of the coil windings respectively.

6 Claims, 12 Drawing Sheets

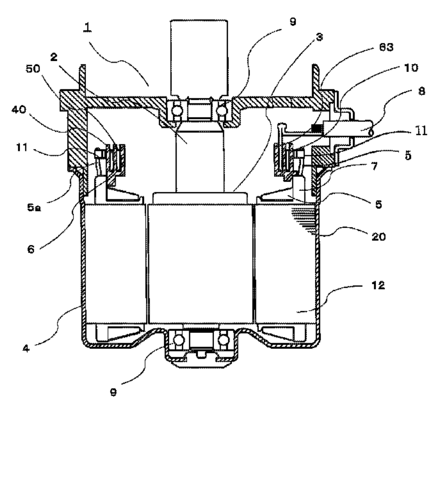

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Fig. 1

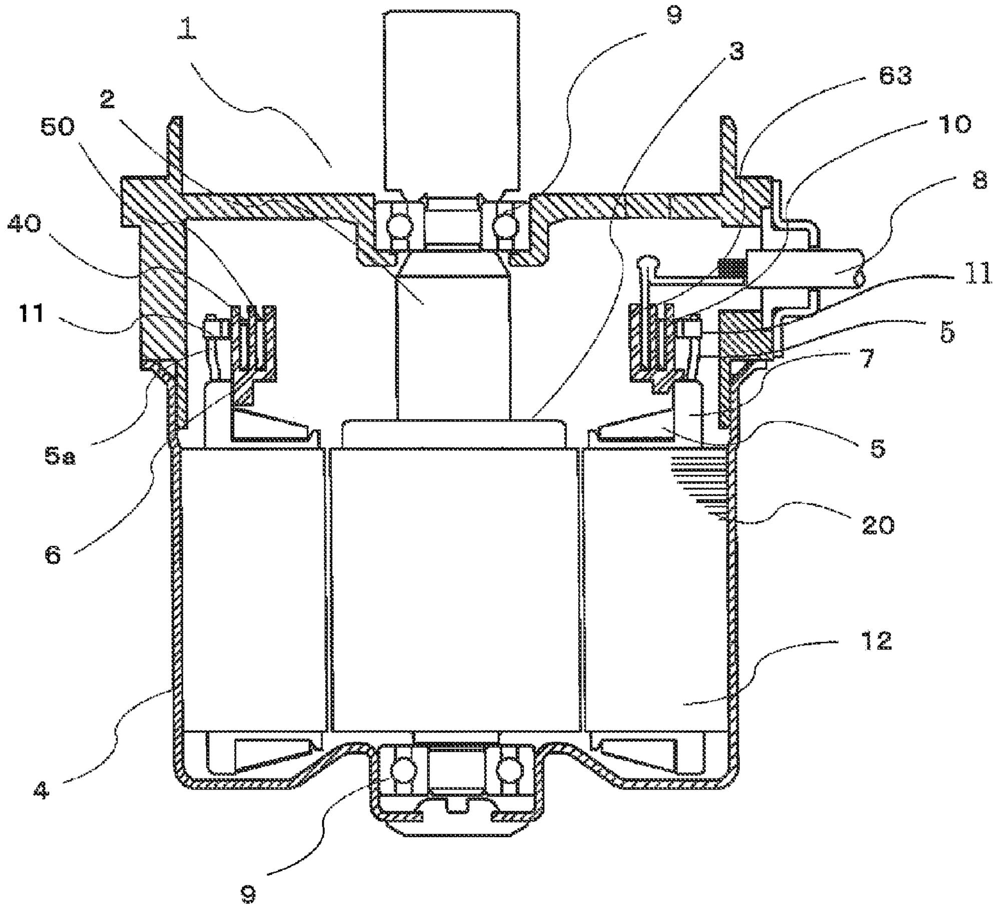


Fig. 2A

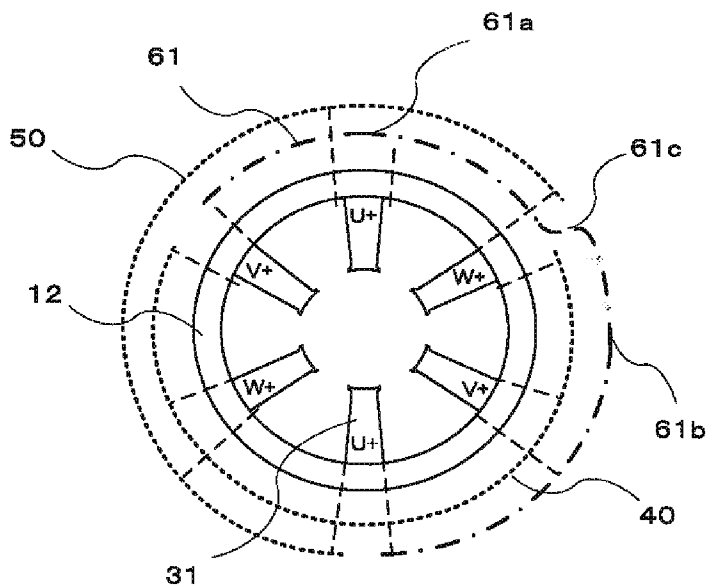


Fig. 2B

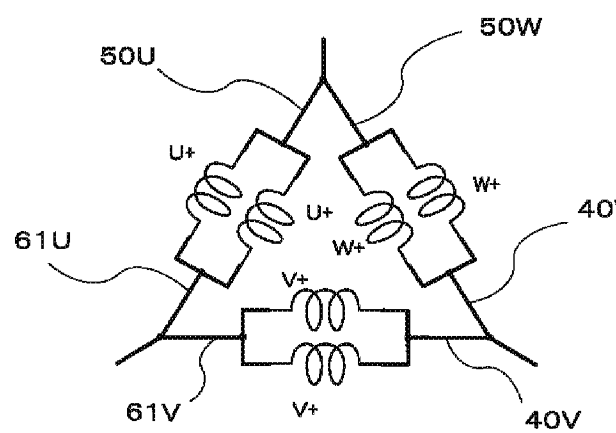
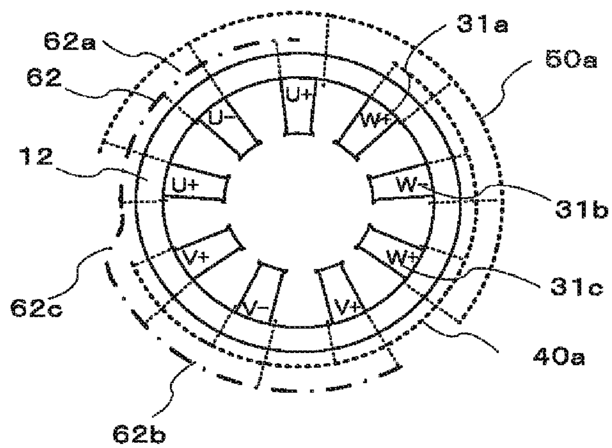


Fig. 3A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62
12
62c
62b
31a
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31c
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U+
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V−
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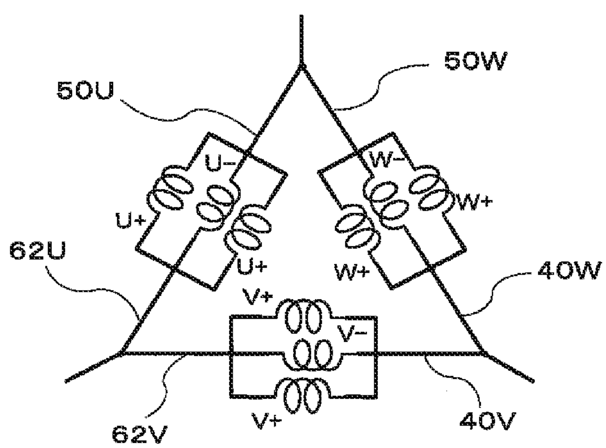
W−
W+

Fig. 3B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50W
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W−
W+
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62U
40W
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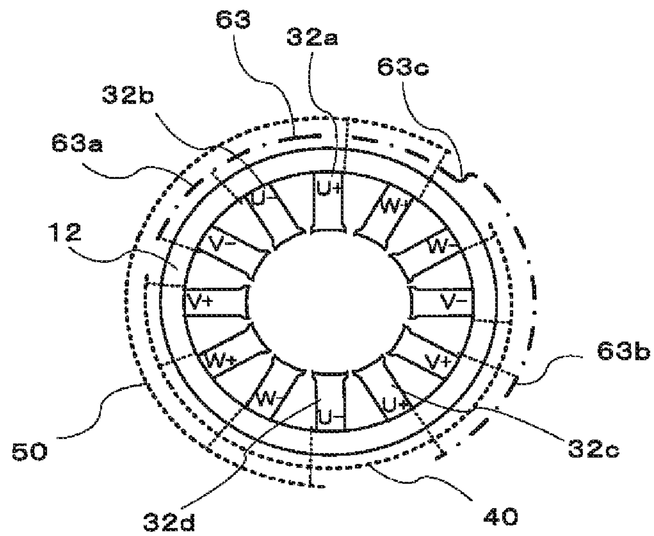
V−
V+
62V
40V

Fig. 4A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W+
V-
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V+
V-
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V+
W-
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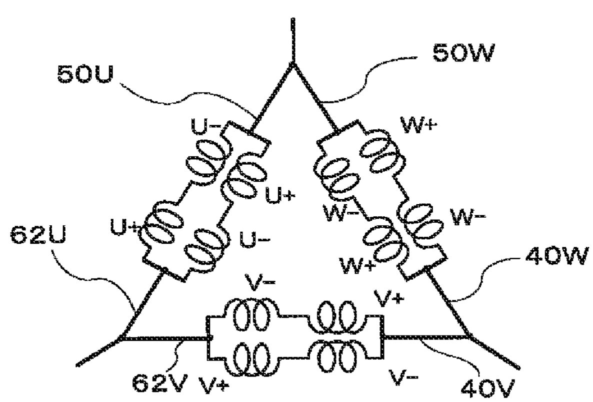
U+
63b
50
32c
32d
40

Fig. 4B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U+
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W-
U-
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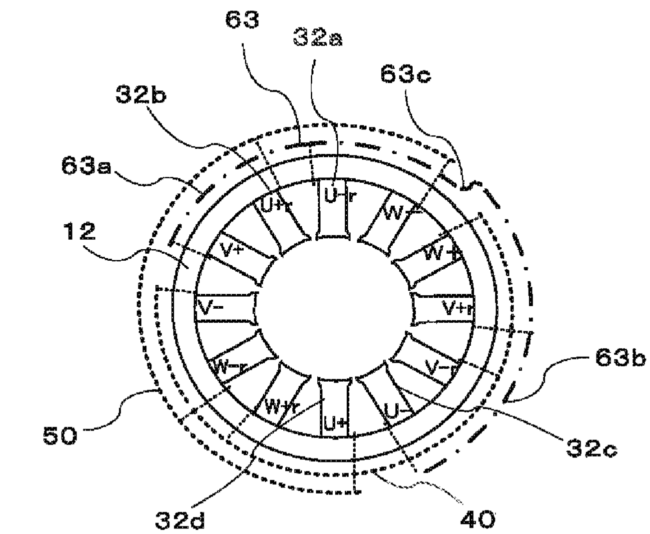
V+
V-
40V

Fig. 5A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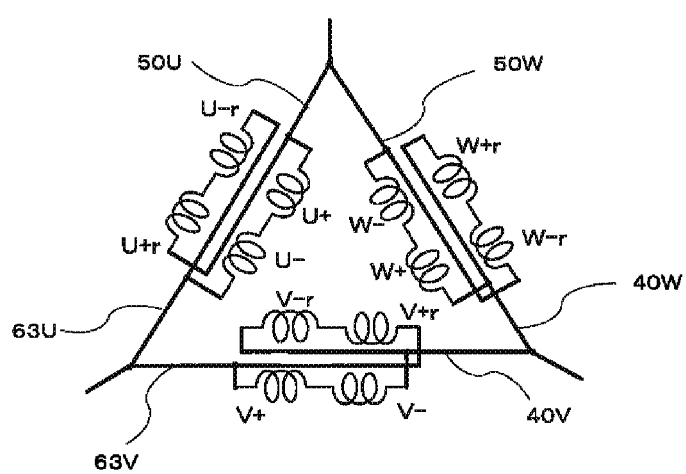
32d
40

Fig. 5B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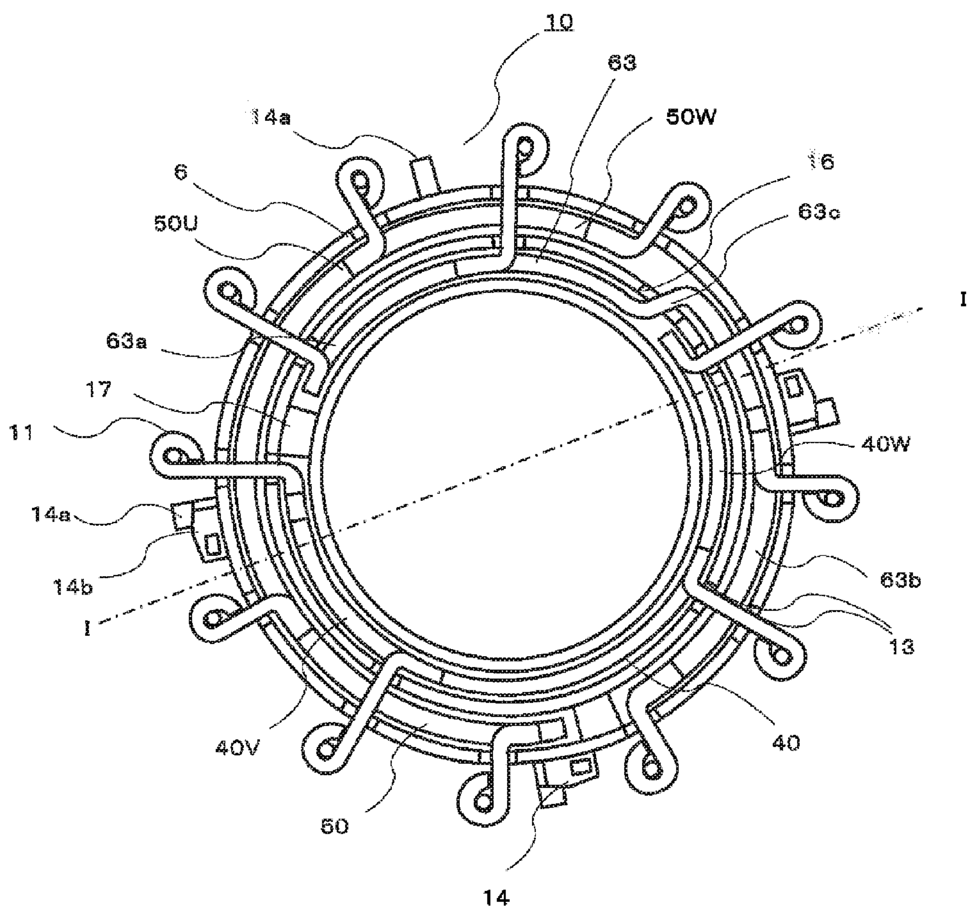
V-
40V
63V

Fig. 6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60
14

Fig. 7

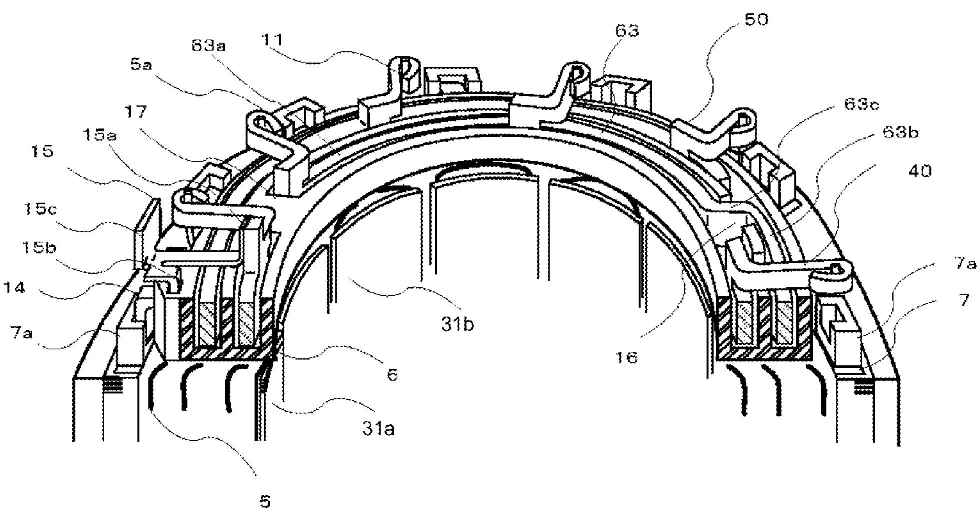


Fig. 8A

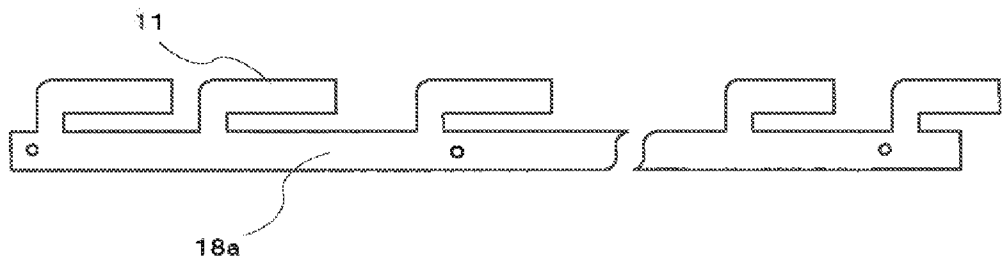


Fig. 8B

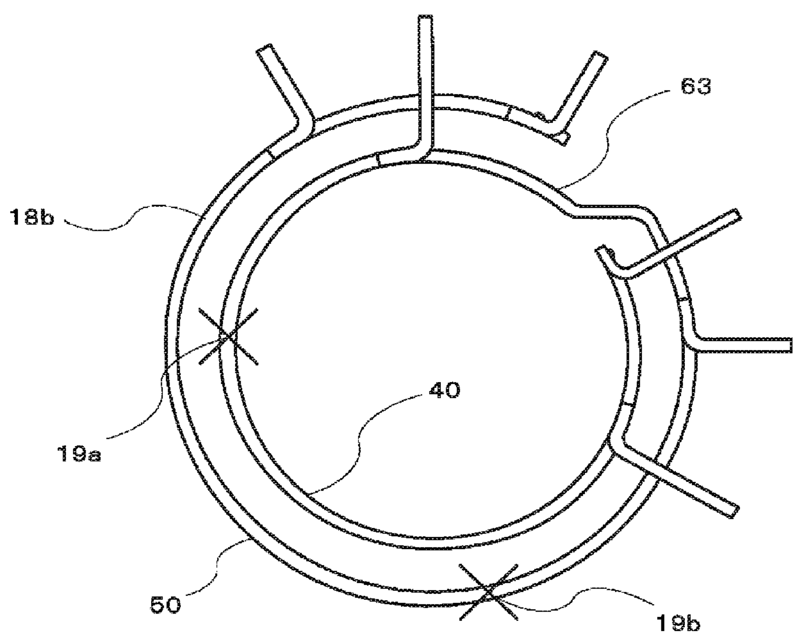


Fig. 9

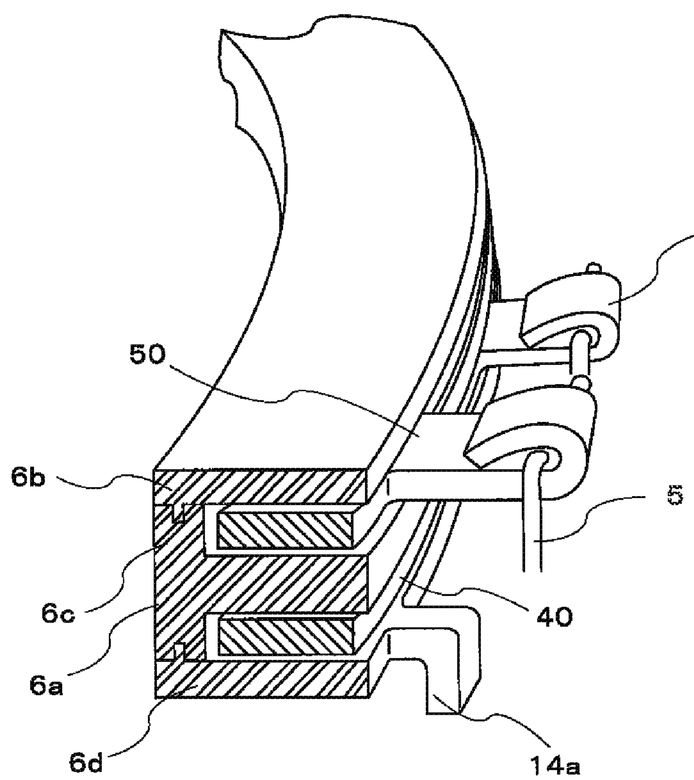


Fig. 10A
PRIOR ART

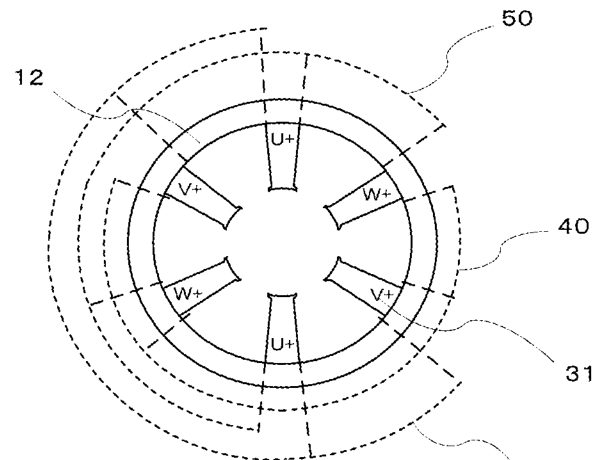


Fig. 10B
PRIOR ART

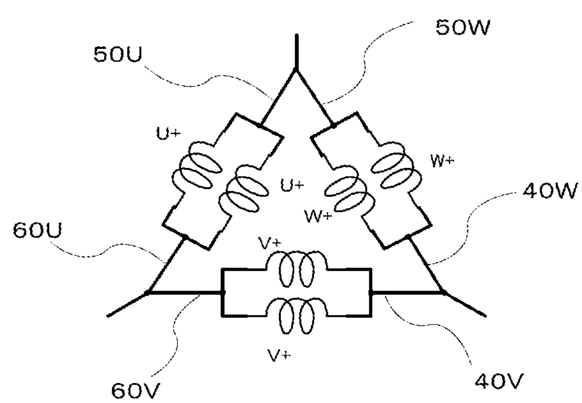


Fig. 11A
PRIOR ART

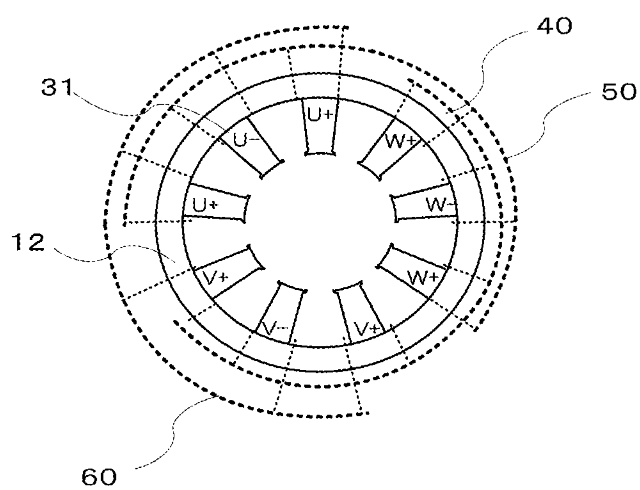


Fig. 11B
PRIOR ART

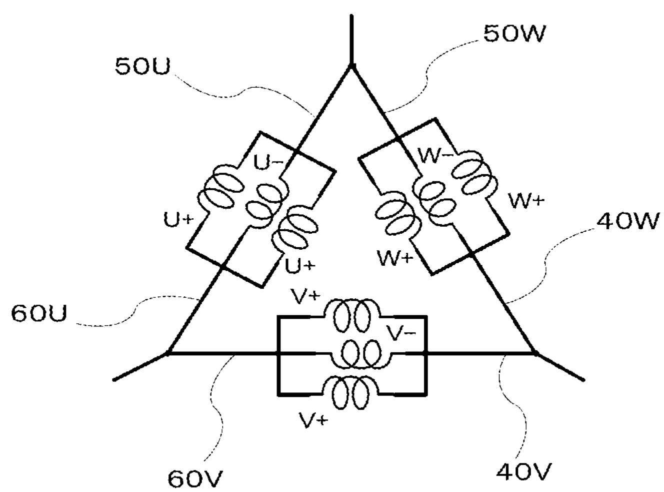


Fig. 12A
PRIOR ART

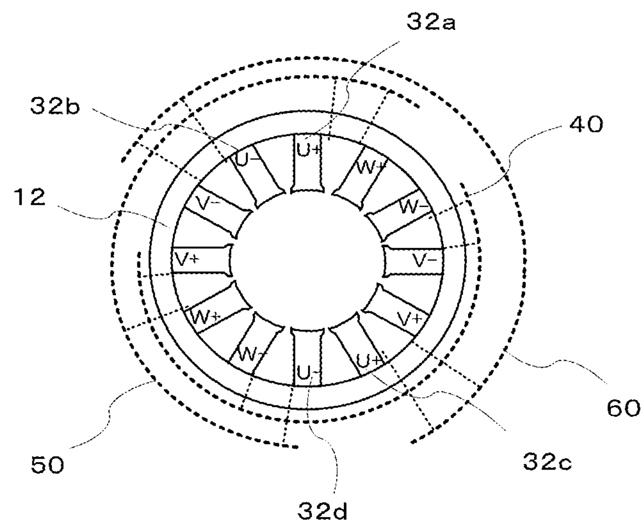
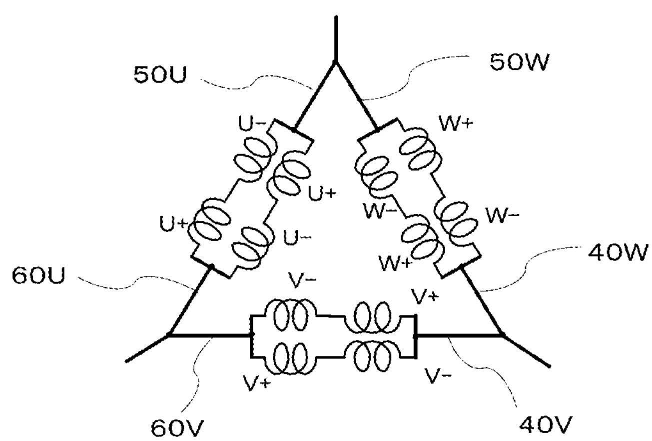


Fig. 12B
PRIOR ART



ROTARY ELECTRIC MACHINE AND METHOD OF MANUFACTURING THE SAME

This application is a National Stage of International Application No.PCT/2011/069422 filed Aug. 29, 2011, the contents of which are incorporated herein by reference in their entirety.

TECHNICAL FIELD

The present invention particularly relates to a connection structure of a plurality of coils of three phase delta connection in a rotary electric machine and a method of manufacturing the same.

BACKGROUND ART

Conventionally, a rotary electric machine is composed of a stator and a rotor; and a plurality of coils are wound around a tooth of the stator core. In an electric motor (motor), the rotor rotates by a magnetic field generated by flowing a current to the coils.

On the other hand, a generator generates electric power by flowing a current to the coils of the stator by rotating the rotor. The current is made to flow or the current flows to the wound coils; and accordingly, the plurality of coils have to be connected in series or in parallel, connection processing of coil terminals is complicate and requires a space in view of manufacturing the rotary electric machine as the number of coil wires increases.

PRIOR ART DOCUMENT

Patent Document

Patent Document 1: Japanese Examined Patent Publication No. 3613262

SUMMARY OF THE INVENTION

Problems to be Solved by the Invention

A coil connection structure in the aforementioned conventional rotary electric machine has a plurality of arm portions integrated with annular belt shape conductive members, the conductive members are concentrically arranged in plurality, the annular conductive members are held on the coil windings of the stator core by an insulating holder, and wound coil ends are extended to be connected to the arm portions.

The connection processing of the coil ends is simplified by this structure and arrangement can be made compact on the upper side of the stator core; however, the belt shape conductive members need a large number of annular members.

The aforementioned coil connection structure of the rotary electric machine, for example, in a type having 12 slot and 24 coil terminals as shown in FIG. **3** to FIG. **5** of the patent document, needs four concentric circle shaped conductive members and there is a room for an improvement in view of workability and in view of space.

That is, the rotary electric machine of three phase windings has triple or more annular conductive members and the connection processing of the coil ends is performed.

The present invention has been made to solve the foregoing problem, and an object of the present invention is to provide a rotary electric machine and a method of manufacturing the same, which are space saving and can further improve workability.

Means for Solving the Problems

According to the present invention, there is provided a rotary electric machine including a stator having teeth to which a plurality of coil windings are attached by winding and a connection member forming a three phase delta connection by the coil windings,

wherein the connection member is arranged on the coil end portion side of the coil windings of the stator, and is composed of an insulating annular groove portion formed with double annular grooves, a first annular conductive member, a second annular conductive member, and a third annular conductive member, the annular conductive members being attached by insertion into the insulating annular groove portion;

the insulating annular groove portion is formed with double grooves of one and the other, and both the grooves are connected via one window portion;

the respective annular conductive members are each formed in a circular arc shape and provided with a plurality of arm portions extended outward in the radial direction of the stator, the plurality of arm portions being connected to the coil end portions of the coil windings respectively;

the first annular conductive member and the second annular conductive member are attached by insertion into different grooves of the insulating annular groove portion, are overlapped at a part of opened sections where a circular arc is not present, are in a positional relationship in which both the annular conductive members are opened, and are attached by insertion so that the window portion is disposed at the position where both the annular conductive members are opened; and

the third annular conductive member is made such that a portion to be attached by insertion into one groove and a portion to be attached by insertion into the other groove are attached by insertion into the insulating annular groove portion via the window portion.

Furthermore, according to the present invention, there is provided a method of manufacturing a rotary electric machine including a stator having teeth to which a plurality coil windings are attached by winding and a connection member forming a three phase delta connection by the coil windings,

wherein the method including a step of manufacturing the connection member,

the manufacturing step of the connection member including: a step of manufacturing an insulating annular groove portion in which double grooves of one and the other are formed and both the grooves are connected via one window portion; a step of manufacturing a first annular conductive member, a second annular conductive member, and a third annular conductive member; and an assembling step of assembling the respective annular conductive members on the insulating annular groove portion,

the manufacturing step of the respective annular conductive members including a step of manufacturing the first annular conductive member, the second annular conductive member, and the third annular conductive member having a crossover portion that connects one groove and the other groove at the center of the window portion, each of the annular conductive members being provided with a plurality of arm portions extended in the radial direction of the stator and being formed in a circular arc shape, and the assembly step including: a step of attaching the first annular conductive member by inserting into the one groove so that the window portion is located in an opened section where a circular arc is not present; a step of attaching by insertion into the groove so that the crossover portion of the third annular conductive member is located in the window portion; and a step of attaching the second annular conductive member by inserting into the other groove so that the window portion is located in an opened section where a circular arc is not present, and

wherein the method including:

a step of fixing the connection member assembled with the respective members to the stator; and

a step of connecting the arm portions and coil end portions of the coil windings.

Advantageous Effect of the Invention

According to a rotary electric machine and a method of manufacturing the same of the present invention, the connection member forming a three phase delta connection by the coil windings is arranged on the coil end portion side of the coil winding of the stator, and is composed of the insulating annular groove portion formed with double annular grooves, the first annular conductive member, the second annular conductive member, and the third annular conductive member, the annular conductive members being attached by insertion into the insulating annular groove portion, whereby there can be obtained the rotary electric machine and the method of manufacturing the same, in which coil terminal processing can be easily achieved, workability is improved, and space saving can be secured.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a sectional view showing a rotary electric machine according to Embodiment 1 of the present invention;

FIG. **2**A and FIG. **2**B are conceptual views showing windings and annular conductive members of a 4 pole and 6 slot type in the rotary electric machine according to Embodiment 1 of the present invention;

FIG. **3**A and FIG. **3**B are conceptual views showing windings and annular conductive members of a 8 pole and 9 slot type in the rotary electric machine according to Embodiment 1 of the present invention; and

FIG. **4**A and FIG. **4**B are conceptual views showing windings and annular conductive members of a 10 pole and 12 slot type in the rotary electric machine according to Embodiment 1 of the present invention.

FIG. **5**A and FIG. **5**B are conceptual views showing other example of windings and annular conductive members of a 10 pole and 12 slot type in the rotary electric machine according to Embodiment 1 of the present invention;

FIG. **6** is a plan view showing a connection member of a 10 pole and 12 slot type in the rotary electric machine according to Embodiment 1 of the present invention;

FIG. **7** is a relevant part perspective view taken along the line I-I of FIG. **6** showing the rotary electric machine according to Embodiment 1 of the present invention;

FIG. **8**A is a front view and FIG. **8**B is a plan view, each showing an annular conductive member in a rotary electric machine according to Embodiment 2 of the present invention; and

FIG. **9** is a relevant part perspective view showing an insulating annular groove portion in a rotary electric machine according to Embodiment 3 of the present invention.

FIG. **10**A and FIG. **10**B are conceptual views showing windings and annular conductive members of a 4 pole and 6 slot type in a conventional rotary electric machine;

FIG. **11**A and FIG. **11**B are conceptual views showing windings and annular conductive members of a 8 pole and 9 slot type in the conventional rotary electric machine; and

FIG. **12**A and FIG. **12**B are conceptual views showing other example of windings and annular conductive members of a 10 pole and 12 slot type in the rotary electric machine.

MODE FOR CARRYING OUT THE INVENTION

Embodiment 1

Hereinafter, Embodiment 1 of the present invention will be described with reference to FIG. **1** to FIG. **4**A and FIG. **4**B. In the respective drawings, identical or equivalent members and portions will be described with the same reference numerals assigned thereto. FIG. **1** is a sectional view showing a rotary electric machine according to Embodiment 1 of the present invention. FIG. **2**A and FIG. **2**B are conceptual views showing windings and annular conductive members of a 4 pole and 6 slot type in the rotary electric machine according to Embodiment 1 of the present invention. FIG. **3**A and FIG. **3**B are conceptual views showing windings and annular conductive members of a 8 pole and 9 slot type in the rotary electric machine according to Embodiment 1 of the present invention. FIG. **4**A and FIG. **4**B are conceptual views showing windings and annular conductive members of a 10 pole and 12 slot type in the rotary electric machine according to Embodiment 1 of the present invention. FIG. **5**A and FIG. **5**B are conceptual views showing windings and annular conductive members of a 10 pole and 12 slot type in the rotary electric machine according to Embodiment 1 of the present invention.

FIG. **1** shows the entire configuration of a rotary electric machine (motor) **1**; and a rotor **2** and a stator **20** are incorporated in a frame **4**. The rotor **2** is provided with a plurality of permanent magnets **3** (details are not shown in the drawing) which are regularly arranged and is rotatably supported by two bearings **9**.

On the other hand, the stator **20** is composed of: a stator core **12** laminated with a large number of magnetic steel sheets; bobbins for coil windings **7**, the bobbin being molded with insulating resin; and coil windings **5** wound around the bobbins **7** by a predetermined winding method.

Further, a connection member **10** is arranged in the motor axial direction (upper direction in FIG. **1**) of the stator core **12**; the connection member **10** is arranged with an insulating annular groove portion **6** molded with insulation material by being fixed to the bobbins **7**; and a first annular conductive member **40**, a second annular conductive member **50**, and a third annular conductive member **61** are attached by insertion into the insulating annular groove portion **6** (two grooves in FIG. **1**).

Furthermore, one side of coil end portions **5***a* of the coil winding **5** is extended from the bobbin **7** and is connected to an arm portion **11** extended from each of the annular conductive members **40**, **50**, and **61**. Further, a connection is made to a lead wire **8** from a part of the respective annular conductive members **40**, **50**, and **61**. A current is supplied from the lead wire **8** to the coil winding **5** through a switching element (not shown in the drawing) to generate a magnetic field to rotate the rotor **2**. The rotary electric machine (motor) **1** of FIG. **1** shows a brush-less motor structure. Incidentally, the annular conductive members **40**, **50**, and **61** are each made of a material equivalent to the coil winding **5**, for example, copper-made.

In the aforementioned brush-less motor, various specific types of connections of the coil windings **5** and the coil end portions **5***a* will be described using FIG. **2**A and FIG. **2**B to FIG. **5**A and FIG. **5**B. In each of the drawings, a three-phase delta connection is made; (a) shows a conceptual view of the respective annular conductive members; and (b) shows an electrical circuit of (a). Three phases are referred to as U phase, V phase, and W phase, respectively; and the respective coils are also similarly referred to as U phase, V phase, and W phase. In the drawings, identical or equivalent members will be described with the same reference numerals assigned thereto.

FIG. **2**A and FIG. **2**B conceptually show the coil windings and the respective annular conductive members **40**, **50**, and **61** of, for example, a motor of 4 poles and 6 slots (hereinafter, referred to as **4**P**6**S). As shown in FIG. **2**B, the coil windings are connected in delta connection by 6 coils. Reference numeral **12** denotes the stator core; and **31** denotes a tooth extended from the stator core **12** toward the center. Respective phase coils are wound around the tooth **31**; however, the coil windings are omitted in the drawing.

Furthermore, a beginning end and a termination end of the coil winding are extended to each tooth **31**; and both the ends are connected in accordance with a circuit diagram of FIG. **2**B to the arm portion (not shown in the drawing, **11** of FIG. **1**) extended from each annular conductive member **40**, **50**, and **61**, which is circular arc-shaped and is opened at one portion.

The coil windings include 6 coils in which 2 coils are connected in parallel per phase. In the conventional connection method, connection is generally made by using annular conductive members **40**, **50**, and **60** for each phase and the annular conductive members are formed in a triple annular shape as shown in FIG. **10**A. This shows that a coil **40**V and a coil **40**W are connected to a first annular conductive member **40**; similarly, a coil **50**W and a coil **50**U are connected to a second annular conductive member **50**; and a coil **60**U and a coil **60**V are connected to a third annular conductive member **60**, respectively. Then, it shows that "+" and "−" are opposite in winding direction. For example, it shows that "+" is wound clockwise toward the center of a circle and "−" is wound counterclockwise. Even if the phase is different, the winding direction shows the same if symbols of "+" and "−" are the same.

On the other hand, Embodiment 1 of the present invention is not configured by triple annular conductive members, but by double annular conductive members as shown in FIG. **2**A. The first annular conductive member **40** and the second annular conductive member **50** are the same as FIG. **10**(*a*); and the third annular conductive member **60** is changed to the third annular conductive member **61** which is composed a conductive member **61***a*,a conductive member **61***b*, and a crossover portion **61***c*.

That is, the conductive member of **61***a* is located on the same circumference as the first annular conductive member **40** on the innermost circumference; and the conductive member of **61***b* is arranged on a second annular position on the outer circumferential side than the first annular conductive member **40**. One coil end portion of the coil **60**U and the coil **60**V is connected to **61***a*, and the remaining other coil end portion is connected to **61***b*.

Further, **61***c* is a crossover portion that transitions from the innermost circumference to the second annular position; and this position is a phase coil position which is not connected (a position where a W phase coil is wound in FIG. **2**A and FIG. **2**B), and utilizes the position of a section where both the first annular conductive member **40** and the second annular conductive member **50** are partially opened.

The positions of the first annular conductive member **40** on the innermost circumference and the second annular conductive member **50** on the second circumference are arranged in this manner and the crossover portion **61***c* is arranged at the position of the tooth **31** which is not required for connection; and consequently, the first annular conductive member **40** on the innermost circumference and the second annular conductive member **50** on the second circumference can be connected. As a result, the aforementioned conventional triple annular structure can be reduced to a double annular structure as in Embodiment 1 of the present invention.

Next, FIG. **3**A and FIG. **3**B show a 8 pole and 9 sleeve (hereinafter, referred to **8**P**9**S) type. Coil windings include 9 coils in which 3 coils are connected in parallel, which is a drawing configuration similar to FIG. **2**A and FIG. **2**B and reference numerals are similarly assigned. The coil windings **5** include 9 coils in which 3 coils are connected in parallel per phase. In a conventional connection method, connection is generally made by using annular conductive members **40**, **50**, and **60** for each phase and the annular conductive members are formed in a triple annular shape as shown in FIG. **11**A. This shows that a coil **40**V and a coil **40**W are connected to the first annular conductive member **40**; similarly, a coil **50**W and a coil **50**U are connected to the second annular conductive member **50**; and a coil **600** and a coil **60**V are connected to the third annular conductive member **60**, respectively. Then, it shows that "+" and "−" are opposite in winding direction. For example, it shows that "+" is wound clockwise toward the center of a circle and "−" is wound counterclockwise. Even if the phase is different, the winding direction shows the same if symbols of "+" and "−" are the same.

Furthermore, also in the connection method of FIG. **3**A, first, a tooth **31***a* and a tooth **31***c* are for "+" windings and a tooth **31***b* arranged therebetween is for "−" winding. Therefore, the teeth of the same phase are adjacent and the coil windings are wound clockwise in the tooth **31***a* and the tooth **31***c*, and the coil winding is wound counterclockwise in the tooth **31***b*. In this manner, the coil windings are wound and respective end portions are connected in accordance with a circuit diagram of FIG. **3**B. In this case, a first annular conductive member **40***a* and a second annular conductive member **50***a* are equivalent to conventional FIG. **11**A. However, a third annular conductive member **62** is composed of a conductive member **62***a*, a conductive member **62***b*, and a crossover portion **62***c*.

That is, the conductive member of **62***a* is located on the same circumference as the first annular conductive member **40** on the innermost circumference and is connected to the coil **60**U; the conductive member of **62***b* is arranged at a second annular position on the outer circumferential side than the first annular conductive member **40** and is connected to the coil **60**V; and both the conductive members are connected to the same number of coil windings.

Furthermore, the crossover portion **62***c* that connects the conductive member **62***a* to the conductive member **62***b* crosses over from the innermost circumference to the second annular groove. The crossover portion **62***c* can be arranged by being located at a position where the first annular conductive member **90** and the second annular conductive member **50** are partially opened and by utilizing the space between the teeth. In this manner, the aforementioned conventional triple annular structure can be reduced to a double annular structure.

Next, a type in which 12 coils of 10 poles and 12 sleeves (hereinafter, referred to as **1012**S) are used in FIG. **4**A and FIG. **4**B and FIG. **5**A and FIG. **5**B will be described. Coil connection processing is similarly performed in a motor in which the coil windings of one phase are configured by 2 parallel groups of 2 coils in series and these are connected in delta as shown in a circuit diagram of FIG. **4**B. For example, conventionally, respective phases are formed in a triple annular shape having annular conductive members **40**, **50**, and **60** as shown in FIG. **12**A. In this case, for example, a series coil wire of U+ and U− is wound around adjacent teeth **32***a* and **32***b* and a series coil wire of the remaining U+ and U− is wound around teeth **32***c* and **32***d* opposite to the teeth **32***b* and **32***a*. Furthermore, U+ and U− are a continuous wire because of the series coil wire and are wound clockwise around the tooth **32***a*. Subsequently, the coil wire is extended to the tooth **32***b* and is further wound counterclockwise.

In the present invention of FIG. **4**A, a first annular conductive member **40** and a second annular conductive member **50** which are the same as the conventional ones are arranged at the same position. On the other hand, coil connection of the remaining coil **60**U and coil **60**V is designed to be connected to a conductive member **63***a* and a conductive member **63***b* of a third annular conductive member **63**, respectively; and the conductive member **63***a* and the conductive member **63***b* are located in a different annular arrangement and these conductive members are connected by a crossover portion **63***c*.

That is, arrangement is made such that one is located on the innermost circumference and the other is located at the second annular position; and the crossover portion **63***c* is arranged at a section where the first annular conductive member **40** and the second annular conductive member **50** are partially opened and at the space between extended wires of coil windings; and therefore the configuration can be made in a double annular shape.

Furthermore, arm portions of the respective annular conductive members **40**, **50**, and **63** are the same number (four) for each conductive member. As for the third annular conductive member **63**, a half (2) of the arm portions is arranged on the innermost circumference and the remaining is arranged at a position corresponding to a second groove. In this manner, the aforementioned conventional triple annular structure can be reduced to a double annular structure.

FIG. **5**A and FIG. **5**B are the modification of FIG. **4**A and FIG. **4**B. As shown in FIG. **5**A, a connection method of coil windings is changed; and further, as for windings designated with a letter "r," the winding directions of "+" and "−" are reversed. By adopting such windings, the winding directions in FIG. **5**B show counterclockwise and clockwise in turn in such a manner that "U+r" is counterclockwise, "U−r" is clockwise, "W−" is counterclockwise, and "W+" is clockwise. When coil winding is performed, winding can be performed according to this regularity; and therefore, effects exist that the configuration of a winding machine is simple, a plurality of the same winding machines can be wound at the same time in the same direction, and winding time can be reduced.

Incidentally, **14**P12S can also be configured as is the case with FIG. **4**A. Furthermore, motors having a further large number of coil windings, such as **12**P18S, **16**P18S, **16**P24S, and **20**P24S are conceivable; however, the double annular shape is difficult. On the other hand, if in the case of one group of three phase windings such as **2**P3S and **4**P3S, a configuration can be achieved by a single annular shape; and therefore, such a configuration is not linked to the present invention.

In the aforementioned description, three annular conductive members are used, each annular conductive member has the same number of arm portions, and the third annular conductive member is provided with the crossover portion that crosses the grooves; and consequently, the triple annular shape in the radial direction of the stator can be changed to the double annular shape, the connection member itself on the stator core is compact, and arrangement can be made within the radial width of the stator core.

Next, further detail of the coil connection of the double annular shape shown in Embodiment 1 and a manufacturing method will also be described. The description will be made on the coil winding (**10**P12S) of FIG. **4**A and FIG. **4**B as an example. A connection member **10** made of a different member is arranged on the bobbin **7** shown in FIG. **1**.

As the manufacturing method, first, the stator **20** wound with coils is manufactured. As for this process, for example, there is a method in which the laminated belt shape stator core **12** l is manufactured, the bobbin **7** is fitted, a coil wire is wound around the bobbin, and then the entire stator **20** is formed in the annular shape. Furthermore, the coil end portions are made to extend outward in the radial direction from the axial direction of the stator core **12**.

On the other hand, as for the connection member **10**, the insulating annular groove portion **6** is manufactured by insulation resin, the first annular conductive member **40** and the second annular conductive member **50** are manufactured, and similarly, the third annular conductive member **63** in which the conductive member **63***a* and the conductive member **63***b* are integrated by the crossover portion **63***c* is manufactured.

Incidentally, the respective annular conductive members **40**, **50**, and **63** are integrally manufactured with the arm portions **11** which are for connecting the coil end portions **5***a* of the coil windings **5**. Next, the second annular conductive member **50** is inserted into the groove on the radially outer side of the insulating annular groove portion **6**; subsequently, the third annular conductive member **63** having the crossover portion **63***c* is inserted; and finally, the first annular conductive member **40** on the innermost circumference side is inserted. Next, the entire connection member **10** having the insulating annular groove portion **6** in which the respective annular conductive members **40**, **50**, and **63** are inserted is attached to the bobbins **7**. Finally, the coil end portions **5***a* of the coil windings **5** are connected to the arm portions **11**. The stator **20** is completed in this state; and therefore, insertion of the stator **20** into the frame **4**, connection to the lead wire **8**, and insertion of the rotor **2** are performed.

Now, the insulating annular groove portion **6** and the respective annular conductive members **40**, **50**, and **63**, which constitute the connection member **10** will be further described by using FIGS. **6** and **7**. In the insulating annular groove portion **6**, "6*2+6=18" cutout portions **13** are cut out at positions where the arm portions **11** which are for connecting to the coil end portions **5***a* of the coil windings **5** are extended. The arm portions **11** of the respective annular conductive members **40**, **50**, and **63** are extended radially outward on these cutout portions **13**.

Furthermore, the window portion **16** is provided and a groove frame is cut so that the crossover portion **63***c* can be arranged in the window portion **16**. In addition, a plurality of holding portions **14** are arranged on the outermost circumference so as to be capable of being supported by the bobbins **7**. Further, these holding portions **14** have two types of shapes; reference numeral **14***a* is a leg portion that is merely supported by the bobbins **7**; and the holding portion

14 has a base **14***b* and the leg portion **14***a* so that a terminal can be placed. As described above, insertion is made into the thus formed insulating annular groove portion **6** in the order corresponding to the respective annular conductive members **50**, **63**, and **40**.

FIG. **7** is a relevant part perspective view in which a cross section taken along the line I-I of FIG. **6** and a part of the annular shape are viewed in a perspective manner. Twelve laminated portion forming a stator core **12** is arranged in the annular shape and the bobbin **7** is provided on each of tooth (e.g., **31***a*,**31***b*)of the stator core **12**. The bobbin **7** is not only wound by the coil winding **5** but also has a projection **7***a* having a concave portion. The projection **7***a* can be used for positioning of the coil end portion **5***a* of the coil winding **5**. Furthermore, the leg portion **14***a* of the holding portion **14** radially extended outward from the insulating annular groove portion **6** can be inserted into the concave portion and the bobbins **7** support the insulating annular groove portion **6** by both concave and convex structures.

A terminal **15** is a member that connects mainly the coil winding **5** and the lead wire **8** of FIG. **1** and the terminal **15** has three end portions **15***a*, **15***b*, and **15***c*. The end portion of **15***a* is extended to the positions of the respective annular conductive members **40**, **50**, and **63** so as to be capable of being connected (for example, welding) to the coil winding **5**. Furthermore, the end portion **15***b* is bent to be inserted into a hole formed in the base **14***b* of the holding portion **14**. This serves to fix the terminal itself. An end part of the end portion **15***c* is a section which is for being connected to the lead wire **8**. The terminal can be configured by such a component different from the annular conductive member; however, as shown in FIG. **1**, the annular conductive member may be directly extended to be an integrated terminal as is the case with the arm portion.

The respective annular conductive members **40**, **50**, and **63** form three types of shapes and have the arm portions **11** which are for connecting to the end portions **5***a* of the coil windings **5**. The arm portions **11** are extended in parallel to annular portions of the respective annular conductive members and can be integrally formed. Furthermore, it also becomes possible to perform fusing welding for connection to the coil end portion **5***a* of the coil winding **5** by shaping so that the end portion of the arm portion **11** is wound around the coil.

Furthermore, the other end of the arm portion **11** has a surface so as to be able to weld to the end portion **15***a* of the terminal **15**. In this case, the plate thickness direction of the conductive member is put vertically in the drawing and the conductive member is inserted into the groove; and consequently, radial width is suppressed, it makes easy to form the annual shape, the surface (belt) is extended in the axial direction, and area capable of being welded to the coil end and the terminal is secured.

The insulating annular groove portion **6** is an E shape having double grooves and triple walls which are for respectively separating these grooves, and this serves to come into contact with the respective annular conductive members and to fix the conductive members. Furthermore, positioning of the third annular conductive member **63** having the crossover portion **63***c* becomes easy by the window portion **16** between the grooves, the window portion being provided at one portion in the insulating annular groove portion **6**.

Moreover, the position of the window portion **16** is located between other two annular conductive members and between the coil end portions **5***a* of the coil windings **5**, and the annular position is effectively utilized. Incidentally, as compared to the cutout portion **13**, cutout depth is different and the window portion **16** is cut out to the bottom of the groove.

Besides, a partition **17** is provided so that positioning of the first annular conductive member **40** and the second annular conductive member **50** can be performed. Therefore, when the first annular conductive member **40** and the second annular conductive member **50** are inserted into the grooves, the insertion is made by bringing end portions of the annular conductive members into contact with the partition **17** and thus the positioning is easy.

The respective annular conductive members **40**, **50**, and **63** are inserted into the thus formed insulating annular groove portion **6** and the terminals **15** are further attached at predetermined three positions to be able to put in a manufacturing process as integrated sub-assembly. In this way, stator assembly wound by coil and the sub-assembly are separately manufactured and the assembly and the sub-assembly are integrated by inserting the sub-assembly from the axially upper portion of the stator assembly; and therefore, assembly can be simplified.

Embodiment 2

Embodiment 2 of the present invention will be described with reference to FIG. **8**A and FIG. **8**B. FIG. **8**A is a front view and FIG. **8**B is a plan view, each showing an annular conductive member in a rotary electric machine according to Embodiment 2 of the present invention.

As described above, three types of components need to be manufacture for the respective annular conductive member **40**, **50**, and **63**. However, these three types of annular conductive members can be manufactured from a single member. FIG. **8**A shows a conductive member **18***a* and there exist a total of twelve arm portions **11** of two types different in length. This sort of belt-shaped conductive member **18***a* is manufactured; subsequently, the conductive member **18***a* is shaped into a double annual shape (only a part of the arm portions **11** is shown) as shown in FIG. **8**B; and then, the conductive member **18***a* is divided into three portions by cutting at "X" marks **19***a*, and **19***b* in the drawing. Accordingly, three types of annular conductive members **40**, **50**, and **63** are completed; and thus, the annular conductive members are inserted in turn respectively into insulating annular groove portion **6**.

In this manner, desired annular conductive members are made by manufacturing one belt-shaped conductive member **18***a* to be formed in the double shape and to be cut at two points; and therefore, working equipment can be reduced and working time can be shortened as compared to the case where different three types of conductive members are manufactured.

Embodiment 3

Embodiment 3 of the present invention will be described with reference to FIG. **9**. FIG. **9** is a relevant part perspective view showing an insulating annular groove portion in a rotary electric machine according to Embodiment 3 of the present invention.

In the aforementioned Embodiment 1, the annular conductive member and the insulating annular groove portion are formed in the double shape in the radial direction; however, as shown in FIG. **9**, an axial two-story structure can be made. In this case, this is not used to put the plate thickness direction of a belt shaped conductive member vertically as described above, but the surface (belt) is used to put the belt shaped conductive member in the same direction as the laminating direction of a stator core **12**. An insulating annular groove portion **6***a* can also be similarly achieved by forming from the aforementioned verticallyfacing E shape to a laterally-facing E shape in cross section, thereby forming the axial two-storied structure; however, axial dimension can be achieved substantially equivalent to the aforementioned Embodiment 1 and Embodiment 2 and coil connection which is compact and good workability can be similarly achieved.

Incidentally, in the case where one opened section of respective annular conductive members **40**, **50**, and **63** is narrower than a half of circular arc, the annular conductive members cannot be inserted into the integrated two-story annular groove portion shown FIG. **9**. In this case, if the annular shaped groove portion of FIG. **9** is divided into three portions of **6***b*, **6***c*, and **6***d*, the annular conductive members can be inserted into the grooves. In this case, if the portions of **6***b* and **6***c* and the portions of **6***c* and **6***d* are formed in a concave and convex structure as shown in FIG. **9**, assembly can be easily performed.

The description has been made on the example of the motor, but this description is not limited to the motor; and this description can also be used for a generator if the generator is a delta connection configuration having a plurality of coil windings. As described above, in the rotary electric machine, the connection structure of the coil winding has the double annular conductive member and the double annular groove portion; and consequently, effects can be exhibited in that a space is saved and workability is improved.

INDUSTRIAL APPLICABILITY

The present invention is suitable for actualizing a rotary electric machine and a method of manufacturing the same, in which coil terminal processing can be easily achieved, workability is improved, and space saving can be secured.

The invention claimed is:

1. A rotary electric machine comprising a stator having a stator core to which a plurality of coil windings are attached by winding and a connection member forming a three phase delta connection by said coil windings,

wherein said connection member is arranged on the coil end portion side of said coil windings of said stator, and is composed of an insulating annular groove portion formed with double annular grooves, a first annular conductive member, a second annular conductive member, and a third annular conductive member, said first annular conductive member, said second annular conductive member, and said third annular conductive members being attached by insertion into the insulating annular groove portion;

the insulating annular groove portion is formed with double grooves of one and the other, and both the grooves are connected via one window portion;

said first annular conductive member, said second annular conductive member, and said third annular conductive members are each formed in a circular arc shape and provided with a plurality of arm portions extended outward in the radial direction of said stator, the plurality of arm portions being connected to the coil end portions of said coil windings respectively;

said first annular conductive member and said second annular conductive member are attached by insertion into different grooves of the insulating annular groove portion, are overlapped at a part of opened sections where a circular arc is not present, are in a positional relationship in which both said annular conductive members are opened, and are attached by insertion so that the window portion is disposed at the position where both said annular conductive members are opened; and

said third annular conductive member is made such that a portion to be attached by insertion into one groove and a portion to be attached by insertion into the other groove are attached by insertion into the insulating annular groove portion via the window portion.

2. The rotary electric machine according to claim **1**,

wherein said first annular conductive member, said second annular conductive member, and said third annular conductive members each has the same number of arm portions;

said third annular conductive member has a crossover portion crossing from one groove to the other groove, and said third annular conductive member on one groove and said third annular conductive member on the other groove are integrally configured via the crossover portion;

the window portion in the insulating annular groove portion is arranged at a section where said first annular conductive member and said second annular conductive member are opened, and between the coil end portions of said coil windings.

3. The rotary electric machine according to claim **2**,

wherein said first annular conductive member, said second annular conductive member, and said third annular conductive members are each formed in a plate shape which faces in the radial direction of said stator in the plate thickness direction, and are formed in a double annular shape in the radial direction.

4. The rotary electric machine according to claim **2**,

wherein said first annular conductive member, said second annular conductive member, and said third annular conductive members are each formed in a plate shape which faces in the axial direction of said stator in the plate thickness direction, and are formed in a double annular shape in the axial direction.

5. A method of manufacturing a rotary electric machine comprising a stator having a stator core to which a plurality of coil windings are attached by winding and a connection member forming a three phase delta connection by said coil windings,

wherein said method comprising a step of manufacturing said connection member,

the manufacturing step of said connection member including: a step of manufacturing an insulating annular groove portion in which double grooves of one and the other are formed and both the grooves are connected via one window portion; a step of manufacturing a first annular conductive member, a second annular conductive member, and a third annular conductive member; and an assembling step of assembling said respective annular conductive members on the insulating annular groove portion,

the manufacturing step of said first annular conductive member, said second annular conductive member, and said third annular conductive members including a step of manufacturing said first annular conductive member, said second annular conductive member, and said third annular conductive member having a crossover portion that connects one groove and the other groove at the center of the window portion, each of said first annular conductive member, said second annular conductive member, and said third annular conductive members being provided with a plurality of arm portions extended in the radial direction of said stator and being formed in a circular arc shape, and

the assembly step including: a step of attaching said first annular conductive member by inserting into the one groove so that the window portion is located in an opened section where a circular arc is not present; a step of attaching by insertion into the groove so that the crossover portion of said third annular conductive member is located in the window portion; and a step of attaching said second annular conductive member by inserting into the other groove so that the window portion is located in an opened section where a circular arc is not present, and

wherein said method comprising:

a step of fixing said connection member assembled with said first annular conductive member, said second annular conductive member, and said third annular conductive members to said stator; and

a step of connecting the arm portions and coil end portions of said coil windings.

6. The method of manufacturing the rotary electric machine according to claim **5**,

wherein the manufacturing step of said first annular conductive member, said second annular conductive member, and said third annular conductive member includes a step of manufacturing said first annular conductive member, said third annular conductive member, and said third annular conductive member by manufacturing one plate shaped conductive member, subsequently by forming in a double annular shape, and then by cutting two points.

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